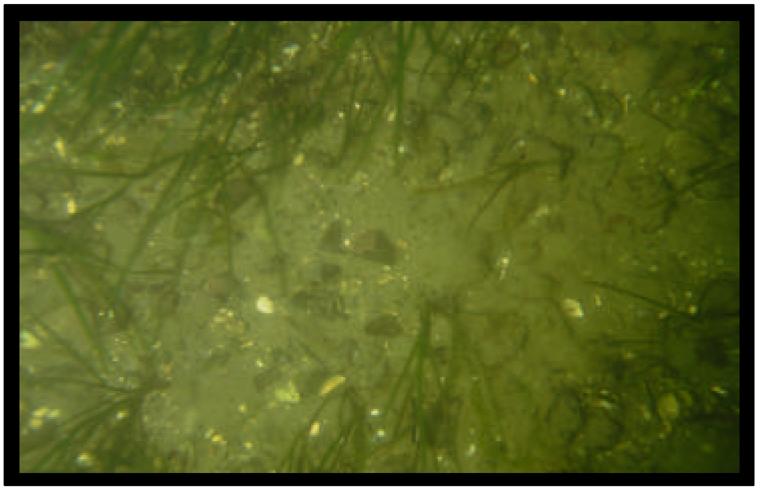
Subtidal Habitats

Functions and Values of Subtidal Unconsolidated Sediments:



What are Subtidal Unconsolidated Sediments?

Unconsolidated bottoms are subtidal extensions of intertidal fine grained flats. Like intertidal flats, sediments are composed of fine clays, silt, mud, sand, gravel and organic matter. They receive replenishment of sediments from the same terrestrial sources as intertidal flats. Subtidal unconsolidated sediments occur in the same areas as intertidal flats but extend far offshore. Some intertidal ledge habitats and boulder beaches blend into unconsolidated sediments in the subtidal.

What are the Functions of Subtidal Unconsolidated Sediments?

Subtidal shallow sandy regions have many similar functions to intertidal mud flats but they are a more diverse and productive habitat. Shallow subtidal soft bottom communities in Portland Harbor support as many as 120 - 36,380 animals / m^2 (Larsen, Johnson, and Doggett 1983). Benthic sediments are homes to billions of microscopic diatoms and bacteria. Diatoms, single-celled algae, convert nutrients into organic matter, oxygenate the sediments and provide food for herbivores. Bacteria feed sediment deposit-feeders and break down organic matter releasing nutrients back into the water column. Animals that contribute to the ecological health of the subtidal community include, horseshoe, hermit and mud crabs, polychaete and oligochaete worms, amphipods, isopods, snails, bivalves, mysid and sand shrimp, brittle and sea stars, sea pens, cumaceans, sand dollars, threespined stickleback, mummichug, alligator fish, rock gunnels, longhorn sculpin, lumpfish, anemones, cusk, hagfish, tautog, redfish, wolffish, cunner, shannies, rocklings, grubbies, rock eels and flounder (Larsen, Johnson and Doggett 1983; Brown 1993; USF&W 1980; Wippelhauser et al. 1997). Eelgrass frequently covers shallow zones adding to the structure and productivity of shallow subtidal regions. Sandlance, an extremely important food resource for fish, mammals and birds, inhabit sandy sediments inshore to the continental shelf (USF&W 1980).

The sublittoral fringe, a narrow zone from the low intertidal to – 5 meters below mean low water, has a high diversity and abundance of invertebrates, high benthic chlorophyll and a reduced number of grazers. Thousands of shrimp and amphipods take refuge here as the tide recedes. The zone is a nursery area for mysid shrimp, amphipods, wrymouth and other marine animals. This region is known to support populations of priapulid worms, quahogs, clams, and oysters (Les Watling, personal communication).

What are the Economic Values of Subtidal Unconsolidated Sediments?

Subtidal unconsolidated bottoms are feeding, spawning, and nursery grounds for commercial species of fish and invertebrates. Sediments contribute to the development of a commercial fishery valued at over $ 200 million in 1997 (NOAA 1997). Juvenile lobsters create subtidal muddy burrows for shelter from predators and establish feeding territories. Additional fisheries include sea urchins, Northern pink shrimp, scallops, blue mussels, rock crabs, sand worms, periwinkles, quahogs, sea cucumbers, black clams and waved whelks (Brown 1993; USF&W 1980). Subtidal fine sediments also support populations of Atlantic herring, American plaice, Atlantic cod, witch flounder, white hake, skate, alewife, winter flounder, yellow flounder, and rainbow smelt (Whipplehauser et al. 1997; USF&W 1980; Stevenson and Knowles 1988).

How Sensitive are Unconsolidated Sediments to Disturbance and Development?

Productive and diverse subtidal unconsolidated sediments, especially shallow subtidal, are classified by DEP as highly sensitive to disturbance and development (see Habitat Rankings). These regions contain a high diversity of animals that are restricted to subtidal areas and can not tolerate great fluctuations in temperature, salinity, and physical disturbance.

What are the Threats to Subtidal Unconsolidated Sediments?

- Dredging, dragging or other major physical disturbances: Dredging results in the loss of productive subtidal habitats. Major dredging operations may cause erosion of intertidal and salt marsh habitats. Physical disturbances liberate toxics and nutrients from unconsolidated sediments into the water column and harm plant and animal communities.
- Dredging disposal: Disposal of sediments smother animal and plant life resulting in the direct loss of species diversity.
- Water quality alterations: Any change in the salinity, temperature, turbidity, or physical properties of the water will negatively affect subtidal communities. Pollutants from point and non-point sources can change communities of infauna and epifauna.
- Physical structures: Physical structures threaten subtidal environments directly and indirectly. Structures replace productive fine sediments with less valuable hard structures. They can shade shallow habitats, change current or tidal flows or directions, alter salinity, prevent sediment movement and block larval and fish passage.
- Mining for sand and gravel: Mining results in the loss of subtidal habitat.
- Trenching***:*** Building trenches for utilities lines temporarily disturbs subtidal habitats.

What are the Permitting Issues of Subtidal Unconsolidated Sediments?

- No physical structures or fill should be permitted in subtidal environments. Filling may violate Maine's water quality laws (see Maine's Water Classification Act) or smother productive habitats. Any activity that would disturb shallow subtidal communities, alter sediment type, or shade subtidal habitats, especially in the sublittoral fringe, should be avoided.
- Temporary impacts to subtidal communities, as in the case of dredging and trenching, may be permitted as long as the sediment type will not be changed and the community can be expected to return to its original condition within a few years time.
- Dredging should be avoided or managed in a careful manner by conducting chemical sediment core analysis before permitting any activity.

Summary of the Functions and Values of Subtidal Unconsolidated Sediments.

Functions	**Values**
1. Production of animals on and within the sediment	Supports lobster, finfish and urchin fishery Foraging habitat for forage fish and top consumers Supports the food web Increases marine biodiversity
2. Primary production from benthic diatoms, algae and eelgrass	Improves water quality Binds sediments therefore reducing erosion Oxygenates sediments and water column Fuels benthic food web Supports commercial fisheries and wildlife
3. Nursery and spawning ground	Promotes growth and existence of species (commercial and ecologically important) Supports the food web and ecosystem health
4. Recycling of nutrients by bacteria	Supports plant and algal growth Supports commercial fisheries Maintains a balanced marine ecosystem
5. Sediment sink and trap	Improves water quality (removes nutrients and toxics) Lessens coastal erosion
6. Refuge during low tide	Protects species from predation and the atmosphere
7. Essential habitat	Provides the soil for eelgrass germination and proliferation Feeds subtidal community

Functions and Values of Subtidal Mixed Coarse:

What is Subtidal Mixed Coarse?

Subtidal mixed coarse is shallow habitats comprised of cobble, gravel and boulders. These habitats are never exposed to the atmosphere. The wave energy is moderate to high. Cobbles are rocks ranging between 2.5 - 10 inches in diameter. The surf can overturn the smaller rocks. Boulders are 1-10 ft in diameter. Mixed coarse habitats dominated by boulder fields are stable habitats. Boulders can not be overturned by waves except by extremely powerful storms. Gravel are small rocks (1-2.5 inches in diameter) that are constantly shifting in the surf. Little information is known about the ecology of subtidal cobble, gravel and boulder habitats. Rocks, especially larger boulders, may be covered by numerous species of macroalgae.

Where is Subtidal Mixed Coarse?

Mixed habitats are often located seaward of moderate and high energy intertidal ledge, boulder, cobble and gravel habitats. Cobble habitats make up only 2- 10 % of the shallow subtidal habitat in Maine (Brown 1993).

What Are the Functions of Subtidal Mixed Coarse?

Mixed coarse habitats have similar functions as intertidal mixed coarse and boulder fields. However, since they are never uncovered by salt water and exposed to the conditions on land they support a greater diversity of algae and animals. Shallow subtidal habitats contain as many as 60 species of macroinvertebrates (Ojeda and Dearborn 1989). Mixed coarse habitats dominated by boulders and cobble create shelter and foraging habitat for lobsters, sea stars, green crabs, shrimp, polychaete worms, sponges, sea anemones, barnacles, hermit crabs, chitons, brittle stars, snails, sea squirts, sea spiders, amphipods, isopods, flat worms and others. Clumps of blue mussels and horse mussels, a dominate subtidal species, create a stable microhabitat for sensitive species within its byssus threads. Threads collect food particles and slow currents allowing species to forage optimally. Coraline algae cover boulders and are grazed upon by snails and urchins (Ojeda and Dearborn 1989). Small fish like the rock gunnel, sea snail, snakeblenny, tautog, and radiated shanny inhabit boulder and cobble bottoms feeding on the abundant marine life (USF&W 1980). Macroalgae cover shallow habitats. Expansive kelp beds increase the functions and values of mixed habitats (see Kelp beds). Boulders break wave energy and slow shoreline erosion.

The alga known as *Leptophytum laeve* is only found within this habitat.

What Are the Economic Values of Subtidal Mixed Coarse?

Mixed coarse sediments supported fisheries landed and valued at over $178 million in 1997 (NOAA 1997). Mixed subtidal habitats are inhabited by commercial species of sea urchins, blue mussels, periwinkles, sand shrimp, sea cucumbers, soft-shell clams, winter flounder, American eel, American lobster and sea raven (USF&W 1980). Kelp and Irish moss may be harvested from these habitats.

Subtidal vegetated and unvegetated unconsolidated coarse sediments are nursery grounds for the "early benthic phase" of the American lobster and rock crabs. Lobster and crab larvae metamorphose into juveniles and move inshore settling out of the plankton and onto the benthos. The cobble-boulder habitat provides shelter and foraging areas for juvenile lobsters. Lobster settlement occurs between August and September (Wahle and Steneck 1991).

How Sensitive Are Subtidal Mixed Coarse to Disturbance and Development?

Mixed coarse subtidal habitats are classified by DEP as highly sensitivity habitats (see Habitat Rankings). They contain diverse assemblages of species nonresistant to perturbations. Mixed coarse habitats are an essential rare habitat that provide protective cover for young settling American lobsters on the outer coast from shallow subtidal to 30 m depth (Wahle and Steneck 1991). Without the protective nature of the habitat, juvenile lobsters, less than ½" in length, would be subject to high mortality from fish and other predators. These specialized habitats are limited in Maine and may limit benthic recruitment of lobsters if the environments are threatened (Wahle and Steneck 1991).

What Are the Threats to Subtidal Mixed Coarse?

- <u>Shading from physical structures</u>: Shading blocks light and reduces growth of algae.
- <u>Removal and/ or disturbance of habitat</u>: Dredging, removal of boulders, scouring by boat traffic, dragging by fisherman, and sediment loading smothers habitat.
- <u>Pollution</u>: Run-off of sediments and pollutants from upland construction sites and parking lots, increases in freshwater discharge, industrial discharges, chlorinated effluent, oil pollution, stormwater run-off, sewage, airborne pesticides from agriculture and others damage subtidal habitats.
- <u>Resuspension of sediments</u>: Resuspension of sediments from dredging, filling, boating and fishing activity smothers habitat. Resuspension of sediments may resuspend larvae and small invertebrates changing the community structure of the habitat and endangering animals and algae.
- <u>Other physical barriers:</u> Any structures (e.g. groin, dam, bridge) that can change current or tidal flows or directions, alter salinity, prevent sediment movement and larval and fish passage threaten the survival of subtidal cobble, gravel and boulder habitats.

- <u>Trenching</u>***:*** Building trenches for utilities lines temporarily disturbs subtidal habitats.

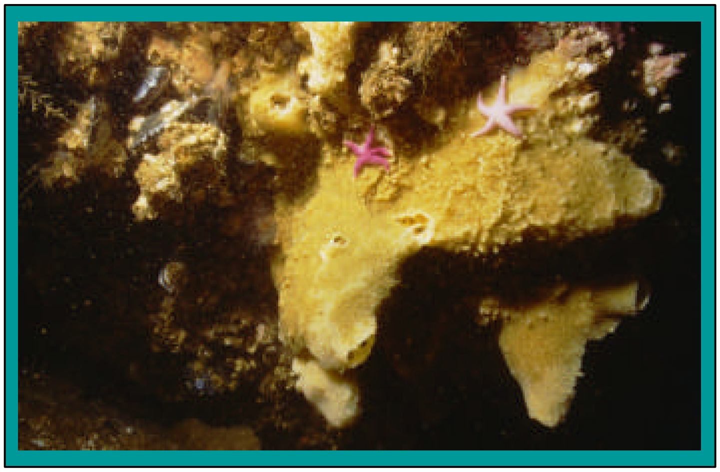
What are the Permitting Issues of Subtidal Mixed Coarse?

- Avoid permitting any activities in cobble, gravel and boulder habitats.
- Avoid permitting any activities that remove algal communities.
- Water dependent structures should be place in areas that will not shade algae or indirectly impact algal beds. If unavoidable, structures should be as narrow as possible, as high as possible and oriented as close to north-south as possible (see eelgrass for guidelines). Avoid permitting activities where boat traffic can shade or scour beds.
- Survey areas for lobsters. Lobsters may concentrate in kelp beds or under boulders and cobbles.
- Avoid sediment disposal on or around subtidal mixed coarse habitats. Avoid activities that will resuspend sediments around habitats.
- Dredging should be avoided or managed in a careful manner by conducting chemical sediment core analysis and functional assessments before permitting any activity.
- If applicable, determine if current velocity, tidal flows, wave energy or water clarity will be altered due to the proposed activity. If so, design project to minimize physical changes.
- Physical barriers should only be permitted in emergency situations.
- Discharges of freshwater or pollutants should be minimized around subtidal habitats.
- New developments in the adjacent upland should maintain pre-development levels of ground water seepage and eliminate increases of stormwater runoff.

Summary of the Functions and Values of Subtidal Mixed Coarse.

Functions	Values
1. Production of animals on boulders, under cobbles, within sediments and on and within algal beds	Supports commercial fishery Supports the food web Supports recreational sport fishery Supports shorebirds, seabirds, seaducks and waterfowl Supports gray and harbor seals
2. Attachment sites for primary producers (see kelp / rockweed)	Food resources for consumers Support commercial fisheries and wildlife Commercially harvested for food and nutrients
3. Slows currents and waves	Reduces shoreline erosion Increases sedimentation
4. Nursery and spawning ground	Helps sustains commercial fishery populations Rare nursery habitat for lobsters Maintains balanced ecosystem
5. Nutrient and contaminant filtration	Improves water quality Supports commercial fisheries
6. Oxygen production	Provides oxygen for marine organisms Improves water quality Supports commercial fisheries
7. Production, accumulation and export of detritus	Fuels microbial, estuarine and offshore food webs Supports commercial fisheries
8. Recycling of nutrients	Supports plant and algal growth Supports commercial fisheries
9. Self-sustaining ecosystem	Increases marine biodiversity Forms numerous and complex microhabitats

Functions and Values of Subtidal Ledge:



What is Subtidal Ledge?

Subtidal ledge is stable bedrock habitats that are never exposed to the atmosphere during low tides. Subtidal ledge contains cracks, crevices, vertical walls and overhangs. Many habitats are located in high energy regions exposed to pounding ocean swells. Ledge habitats slope to the seafloor and often blend into boulder fields or soft unconsolidated bottoms. Algae and animals colonize free space on the ledge and often form multiple layers of organic material. In cold winters, ice can scour the ledge in sheltered areas removing all layers of plant and animal growth.

Where is Subtidal Ledge Located in Maine?

Subtidal ledge is located off rocky shores on the mainland and offshore islands of Maine. Intertidal ledge extends offshore creating subtidal bedrock features (see intertidal ledge for distribution). Additional ledge habitat is found on offshore rock pinnacles in the Gulf of Maine and near Mt. Desert.

What are the Functions of Subtidal Ledge?

Subtidal ledges have similar functions to low intertidal ledge habitats but they <u>have a greater diversity of algae and animals and complexity of horizontal and vertical communities.</u> Diatom mats cover ledge and feed herbivorous gastropods. Kelp beds, red and green algae, and horse mussel communities create three-dimensional structures, trap sediments and provide spatial refuges that result in a high diversity of marine species including sea urchins, shrimp, worms, herbivorous amphipods, sea cucumbers, snails, sea stars, limpets, nudibranchs, chitons, hermit crabs, spider crabs and other aquatic organisms. Sessile suspension-feeding animals (e.g. sponges, polychaete tube worms, tunicates) and predatory animals (e.g. anemones) layer on top of coralline algae and also trap sediments creating additional complex communities of infauna species like bivalves, brittle stars, and worms below surface waters. Mats of amphipods live within canopies of red algae. Cracks and crevices provide spatial refuges from predation for invertebrates and fish (Ojeda and Dearborn 1989; Mathieson et al.1991).

At shallow depths, seabirds, loons, eider ducks, goldeneyes, mergansers, harlequin ducks, oldsquaw, scoters, herring gulls, and grebes feed on subtidal invertebrates (Mathieson et al.1991; USF&W 1980).

Numerous small fish that feed top predators seek shelter and forage within this environment. Sea raven, eelpout, wrasse, radiated shannies, rock gunnel, ocean pout, cunner, snake blenny, sculpins, smelt, grubby, lumpfish, rocklings, rock eels, tautogs, cusks, and goosefish inhabit this zone (Brown 1993; Ojeda and Dearborn 1989, 1991; Factor 1995).

Ledge intercepts open ocean generated waves, breaks wave energy and decreases shoreline erosion.

What are the Economic and Recreational Values of Subtidal Ledge?

Subtidal ledge supports at least twenty-nine commercial species in Maine landed and valued at over $175 million in 1997 (NOAA 1997). Rock crab, Jonah crabs, sand shrimp, green sea urchin, sea cucumber, blue mussel, oyster, horse mussel, periwinkle, and whelks settle, feed and seek shelter in ledge environments (Brown 1993; Ojeda and Dearborn 1989, 1991). Lobsters occupy the edges of kelp beds for shelter and foraging (Bologna and Steneck 1993). American eel, haddock, redfish, wolffish, yellowtail flounder, winter flounder, spiny dogfish, mackerel, sea raven, pollock, Atlantic herring, Atlantic cod, American shad, silver hake, bluefish, cunner, and skate forage in subtidal ledges (Brown 1993; Ojeda and Dearborn 1989, 1991; Mathieson et al.1991). Kelp and Irish moss are directly harvested from subtidal ledges on the mainland and offshore islands.

Vegetated off-shore rock pinnacles are used as substratum for the deposition of Atlantic herring eggs. These habitats are believed to reduce larval mortality of fish (Mathieson et al. 1991).

Striped bass, one of the most important coastal recreational fisheries in Maine, live and forage within subtidal ledge habitats (USF&W 1980).

How Sensitive are They to Disturbance and Development?

Subtidal ledge environments are a multi-functional productive habitat that has been classified by DEP as having a high sensitivity to disturbance and development (see Habitat Rankings). Subtidal ledge environments contain unique species that cannot resist perturbations or adapt readily to other habitats.

What are the Threats to Subtidal Ledge?

- <u>Shading from physical structures</u>: Shading blocks light and reduces algal growth.
- <u>Removal of habitat</u>: Blasting of ledge removes habitat and animal communities.
- <u>Fill</u>: Filling of habitat smothers algae and animals and reduces attachment sites.
- <u>Pollution</u>: Run-off of sediments and pollutants from upland construction sites, increases in freshwater discharge, industrial discharges, oil pollution, stormwater run-off, sewage, airborne pesticides from agriculture and others all damage subtidal ledge communities.
- <u>Resuspension of sediments</u>: Resuspension of sediments from nearby dredging, filling, boating and fishing activity smother animals on ledge.
- <u>Dragging</u>: Dragging by fisherman removes kelp and invertebrates and reduces shelter.

What are the Permitting Issues of Subtidal Ledge?

- Avoid permitting any activity in subtidal ledge environments.
- Avoid permitting activities that remove, disturb or change habitat structure.
- Water dependent structures should be place in areas that will not shade subtidal ledge communities. If unavoidable, structures should be as narrow as possible, as high as possible and oriented as close to north-south as possible (see eelgrass for guidelines). Avoid permitting activities where boat traffic can affect algae and organisms.
- If applicable, determine if current velocity, tidal flows, wave energy or water clarity will be altered due to the proposed activity. If so, design project to minimize physical changes.
- Discharges of freshwater or pollutants should be minimized around ledge habitats.
- New developments in the adjacent upland should maintain pre-development levels of ground water seepage and eliminate increases of storm water runoff.

Summary of the Functions and Values of Subtidal Ledge.

Functions	**Values**
1. Production of animals on rocks, in cracks and crevices, on and within algal beds	Supports commercial fishery Supports the food web Supports recreational sport fishery Supports shorebirds, seabirds, seaducks and waterfowl Supports gray and harbor seals
2. Permanent and stable attachment sites for primary producers such as diatoms, kelp, red algae and rockweed. (see kelp/rockweed)	Food resources for consumers Support commercial fisheries and wildlife Commercially harvested for food and nutrients
3. Slows currents and waves	Reduces shoreline erosion Increases sedimentation
4. Nursery and spawning ground	Helps sustain commercial fishery populations Maintains balanced ecosystem
5. Nutrient and contaminant filtration	Improves water quality Supports commercial fisheries
6. Oxygen production	Provides oxygen for marine organisms Improves water quality Supports commercial fisheries
7. Production, accumulation and export of detritus	Fuels microbial, estuarine and offshore food webs Supports commercial fisheries
8. Recycling of nutrients	Supports plant and algal growth Supports commercial fisheries
9. Self-sustaining ecosystem	Increases marine biodiversity Forms numerous and complex microhabitats